

# LESSON:

# Weighing the Effects of Lead

**Summary:** Students read about the effects of lead exposure in adults and weigh a decision to

change public policy using points drawn from the article.

**Lesson Type:** Focus Lesson—This lesson explores a concept from a Focus article.

**EHP Article:** "The Weight of Lead: Effects Add Up in Adults"

EHP Student Edition, April 2007, p. A31-A36

http://www.ehponline.org/docs/2007/115-1/focus-abs.html

**Objectives:** By the end of this lesson, students should be able to

1. discuss the findings of recent research on low-level lead exposure in adults;

2. describe the effects of lead on the cardiovascular and renal systems;

3. identify subpopulations at higher risk of harm from lead exposure; and

4. evaluate the suggested reduction in the lead exposure standard as a solution to

the problem of lead in our environment.

Class Time: 1.5 hours

Grade Level: 10-12

Subjects Addressed: Physiology, Environmental Science, Biology, and Health

# Prepping the Lesson (15 minutes)

## **INSTRUCTIONS:**

- 1. Download the entire April 2007 *EHP Student Edition* at <a href="http://www.ehponline.org/science-ed/">http://www.ehponline.org/science-ed/</a>, or download just the article "The Weight of Lead: Effects Add Up in Adults" at <a href="http://www.ehponline.org/docs/2007/115-1/focus-abs.html">http://www.ehponline.org/docs/2007/115-1/focus-abs.html</a>.
- 2. Review the Background Information, Instructions, and Student Instructions.
- 3. Make copies of the Student Instructions.

## **MATERIALS** (per student):

- 1 copy of the April 2007 EHP Student Edition, or 1 copy of "The Weight of Lead: Effects Add Up in Adults," preferably in color
- 1 copy of the Student Instructions

## **VOCABULARY:**

- µg/dL
- atherosclerosis
- cognitive
- cumulative
- endothelial
- OSHA
- osteoporosis
- oxidative stress
- renal
- smelting
- subclinical
- symptomatic
- threshold
- toxicity



### **BACKGROUND INFORMATION:**

The article provides sufficient background information about lead toxicity for the completion of the exercise. The study of lead has historically focused on acute toxicity (from a high dose in a short time) or chronic effects (from low doses over a long time) in children. Children are known to suffer clinical effects at lower levels than adults, including serious developmental effects such as reduced IQ. This article provides a good example of the research currently under way on substances at levels well under the established NOAEL, or "no observed adverse effects level." Surprisingly, although some known environmental hazards (such as lead) do show harmful effects even at very low levels, others (such as radiation and carbon monoxide) are being shown to have beneficial and even therapeutic effects under controlled conditions. This unexpected phenomenon is referred to as "hormesis." This exciting new research on the harmful and helpful effects of low-level exposures demonstrates the urgent need, as technology and measurement capabilities improve, for continued exploration into various environmental agents' effects on human heath.

### **RESOURCES:**

Environmental Health Perspectives, Environews by Topic page, http://ehp.niehs.nih.gov/. Choose Lead, Metal Toxicity, Neurology

Environmental Health Perspectives, "New Study Suggests Federal Standards for Blood Lead May Be Too High to Protect Children's Intelligence" [press release], http://www.ehponline.org/press/011306.html

Occupational Safety and Health Administration, <a href="http://www.osha.gov/">http://www.osha.gov/</a>

Raloff J. 2007. Counterintuitive toxicity. Science News 171(3):40; http://www.sciencenews.org/articles/20070120/bob8.asp.

# Implementing the Lesson

#### **INSTRUCTIONS:**

- 1. Hand out the Student Instructions and the article "The Weight of Lead: Effects Add Up in Adults."
- 2. Allow approximately 30 minutes for students to read the article, or assign the reading as homework.
- 3. Have students answer the questions on the Student Instructions and prepare to discuss their answers to the final question.
- 4. Direct the students in an informal discussion of how to apply research findings to public policy, utilizing points from the article. Some points you may want to discuss include:
  - consideration of susceptible populations in policies (e.g., pregnant women)
  - conclusions based upon recent research results
  - the potential for accumulation of the chemical or exposures within and outside of the workplace
  - influences from industries that may be impacted by public policy

## **NOTES & HELPFUL HINTS:**

- 1. An excellent social studies activity would be to have students further investigate and discuss the factors that influence public health laws and standards for agencies like the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA).
- 2. Students could investigate other common chemical exposures in the workplace and compare the OSHA standards to other exposure standards or limits set or recommended by other agencies/organizations like the EPA, state environmental agencies, and the National Toxicology Program.

## Aligning with Standards

## **SKILLS USED OR DEVELOPED:**

- Communication (note-taking, oral, written—including summarization)
- Comprehension (listening, reading)
- Critical thinking and response

### **SPECIFIC CONTENT ADDRESSED:**

- Emerging research on lead
- Low-level effects of toxicants
- Occupational health standards



#### NATIONAL SCIENCE EDUCATION STANDARDS MET:

## **Science Content Standards**

## **Unifying Concepts and Processes Standard**

- Systems, order, and organization
- Evidence, models, and explanation
- Change, constancy, and measurement
- Form and function

## **Science as Inquiry Standard**

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

## **Science and Technology Standard**

Understanding about science and technology

## **Science in Personal and Social Perspectives Standard**

- Personal and community health
- Population growth
- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

## Assessing the Lesson

**Step 1:** Using a dictionary or the Internet, define the following terms:

**Occupational Safety and Health Administration (OSHA):** Federal agency that sets and enforces health and safety rules for workers.

 $\mu$ g/dL: Micrograms per deciliter. A microgram is a millionth of a gram. A deciliter is a tenth of a liter. This is the standard measure for lead in blood. Example: 15  $\mu$ g/dL is 15 micrograms of lead per deciliter of blood, or 0.000015 gram of lead per 10 liters of blood.

**Subclinical:** "Not detectable or producing effects that are not detectable by the usual clinical tests" (source: Merriam-Webster Online dictionary, <a href="http://www.m-w.com/dictionary/subclinical">http://www.m-w.com/dictionary/subclinical</a>).

- Step 2: Read the article "The Weight of Lead: Effects Add Up in Adults" and answer the following questions.
  - a) Summarize the effects of low levels of lead on:
    - the circulatory system—Low levels of lead can lead to increased blood pressure and increased rates of mortality from heart disease and stroke by promoting the growth of atherosclerotic plaques and an increase in oxidative stress.
    - the renal system (kidneys)—Low lead levels have been shown to cause kidney damage resulting in lower rates of creatinine clearance and possibly increasing blood volume and blood pressure.
  - b) What individual variations apparently put people at higher risk of harm from low levels of lead?

Age—children and the elderly

Genetic variations—certain genes may predict harm

Medical conditions—pregnancy, obesity, diabetes

Previous exposures to lead and the amount stored in the bone

Current exposures to lead



c) The article concludes with the following quote: "So we need to not be complacent and say, 'We've lowered lead,' but rather we need to think about it in terms of how can we reduce lead more, such that we eliminate this environmental toxicant. There's really no biological function of lead, and there's really no reason why we should be exposed to it."

Do you agree that elimination of lead from the environment should be the goal of public policy decisions? What factors might need to be considered before making changes to the current standards?

Students answers may vary. Look for clearly written, logical responses. A sample response might be: It would be very challenging to return to environmental conditions of "pre-industrial times." Factors that must be considered include the costs of changing workplace processes, conditions of employment and compensation for exposure, and the costs of the environmental remediation to eliminate this ubiquitous industrial contaminant. The key to improving public safety and environmental health is to focus on reducing exposure. By mandating changes to standards that create measurable reductions in blood lead across the population and by identifying vulnerable populations for exclusion from hazardous conditions, we can reduce the costs of the policy change while maximizing the benefits to society.

## Authors and Reviewers

Authors: Wendy Stephan and Lisa Pitman, University of Miami

Reviewers: Stephanie Bishop, Susan Booker, Erin Dooley, Stefani Hines, and Joseph Tart

Give us your feedback! Send comments about this lesson to ehpscienceed@niehs.nih.gov.

Step 1:	Using a dictionary or the Internet, define the following terms:
	Occupational Safety and Health Administration (OSHA):
	μg/dL:
	Subclinical:
Step 2:	Read the article "The Weight of Lead: Effects Add Up in Adults" and answer the following questions.
	<ul><li>a) Summarize the effects of low levels of lead on:</li><li>• the circulatory system</li></ul>
	the renal system (kidneys)

b) What individual variations apparently put people at higher risk of harm from low levels	s of lea	levels	low	from	harm	of	risk	higher	people a	but /	parently	variations a	individual	What	b)
--	----------	--------	-----	------	------	----	------	--------	----------	-------	----------	--------------	------------	------	----

- c) The article concludes with the following quote: "So we need to not be complacent and say, 'We've lowered lead,' but rather we need to think about it in terms of how can we reduce lead more, such that we eliminate this environmental toxicant. There's really no biological function of lead, and there's really no reason why we should be exposed to it."
  - Do you agree that elimination of lead from the environment should be the goal of public policy decisions? What factors might need to be considered before making changes to the current standards?